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Automated System for Experimental Study of Foundation Bases Performance

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Abstract

This article provides information about the program processing strain gauge measurements of the automated system of scientific research into bases and foundations. The software is designed for experimental studies of stress-strain state of the foundations with the use of strain gauges. Strain measurement processing system allows for real time experimental studies both of the models, and in-situ. The technique for the experimental study using strain gauge measurement processing system is presented.

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Keywords: automated system; strain gage instrumentation; distribution of stresses and strains in the soil massif; experimental studies

1. Introduction

The most reliable, time-consuming and expensive way to study the behavior of the foundations is an experimental research. Conducting experimental studies are difficult by the fact that is made or natural object or model. Getting any information associated with high costs for the manufacture of the device or object model, using expensive equipment and materials, selection of technology and means of carrying out the experiment. Efforts arising at the base of the foundation plates, a complex physical-mechanical process, the study of which is the source of true information about the behavior of the base load. That is why the results of experimental studies so thoroughly studied by researchers because they are the most valuable data bank. With the development of techniques and methods of experiments is possible to obtain more and more extensive information about the processes occurring in the soil foundation base, and as a result of use of this information in the development of the theory of calculation.

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2. Solution Description

The results of theoretical research, hypotheses and theories require special inspection, which will be available during the pilot studies. A special place, even in the modern development of the numerical simulation, experiments take in geotechnics and foundation engineering. The main drawback of such research is often a complexity of operations for the preparation and processing of the results of experiments.

Carrying out experimental research has several objectives. The main goal of such research is to create a model to the real picture of the interaction of plant and soil mass. After that, we can say that the data obtained as a result of the experiment on the stress-strain state (NDS) base, are a reflection of the processes occurring at the base of the structure.

Numerous experimental studies conducted at the Department "Industrial, civil engineering, geotechnical and foundation engineering" South-Russian State Technical University (Novocherkassk Polytechnic Institute) named after M.I. Platov, subject to certain methodology of the experiment [1]. This method combined the laws and principles of modeling and allows you to explore changes in the NDS laws of the base and foundation models in the process of loading from small to the limit on the strength of the base load in terms of spatial, axially symmetric and planar problems [2].

Using the extensive experience of experimental research on models of stress-strain state of structures and underground bases, presented in [3-13], and advanced information technology has created on the basis of a modern method electrical-tensor-resistive program "strain measurement processing system" ("SMSP") (Fig. 1.). On the software product received a certificate of registration [14] and it is widely used in the laboratory SRSTU (NPI) of the Department "Industrial, civil engineering, geotechnical and foundation engineering" in experimental studies on models [15, 16].

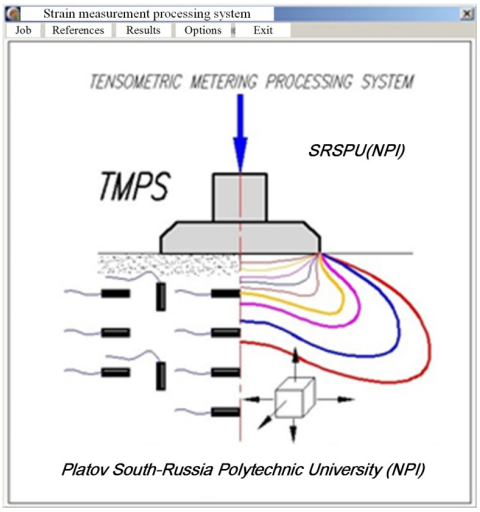

Fig.1. "SMSP " program interface

Research Methodology involves the use of a secondary measurement technology and a variety of stress strain gauges (mezdoz) and strain SRSPU design [17, 18] and NIISK [19, 20] to study the required NDS settings structures or systems. In addition to the laboratory strain of equipment needed model studied structures and base load device, calibration equipment for sensor and interface unit strain with computer equipment.

SMSP (strain measurement system processing) brings together all the elements of the laboratory and experimental stages and allows experiments in real-time with an automated analysis of results.

Methods of experimental studies using strain gauge measurement processing system comprises the following steps:

1. Create a database of devices.

2. Calibration of the instrument.
3. Creation of the experimental design.
4. Carrying out the experiment.
5. Analysis of the results.
6. Document and report creation.

In the first phase of the experimental studies are needed to create a database of devices, which should include all the primary strain gauge measuring equipment used in the experiment. To do this, the program has a reference instrument, in which the sensors are making a number indicating their main characteristics, type and model. Thus, all the primary equipment is classified.

The next step is calibration of sensors. The program allows the simultaneous calibration of five devices.

Calibration window contains the main characteristics of the device, according to the nomenclature recorded in the reference devices, and at the end of the calibration results in tabular and graphical form.

Data on calibration of sensors are needed to decrypt and analyze measurement results obtained from the experiment.

The next step - the creation of an experimental scheme involves the preparation of sensors layout, create a list of the sensors used in this experiment, an indication of the provisions of sections which will build diagrams and contour plots in the analysis of experimental results (Fig 2.).

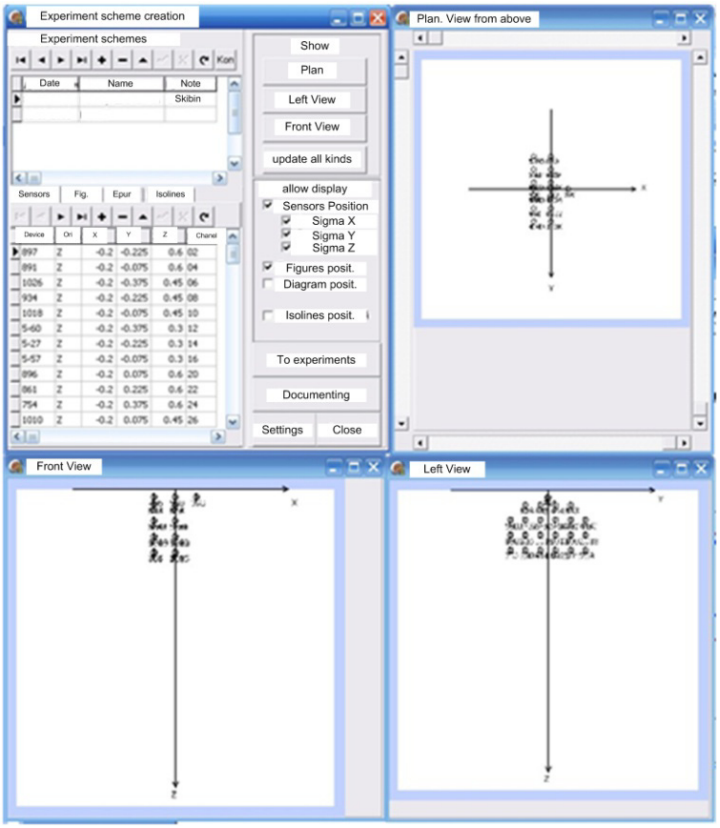

Fig.2. Window "Create experimental design"

Window "Create experimental design" contains 5 major fields: the scheme of the experiment, circuit components, control and visualization of the control panel cover and enter the experimental treatment, documentation.

After you create the experimental design is necessary to prepare all the equipment to conduct the experiment. Set sensors according to the schemes of the experiment, set the foundation model, lead loading devices into the operating position, set other measuring equipment (deflectometer, messury).

Experimental studies carried out on the next stage of the program complex with an appropriate window. Window "Carrying out the experiment" contains measurement protocol at every stage of research (point load) and overall measurement protocol, which is filled for each stage. These steps fixed to the settings: the efforts and time of the title.

Analysis of the results produced in the corresponding tab, triggered by the sub-menu "Operation". the results of the analysis window contains the results of measurements and processing of measurement data, information on the instruments used in this experiment, and the graphics window to display diagrams and contour (outline, front view, left).

In Fig. 3 shows an example of the experimental data of normal contours of the vertical stress at the base of the foundation of the model at different stages of loading obtained using a graphical software package application "SMSP".

If in the course of the experiments appear incorrect data associated with damage to the sensor or a lack of signals that affect the accuracy of the results in an option to adjust the experimental results.

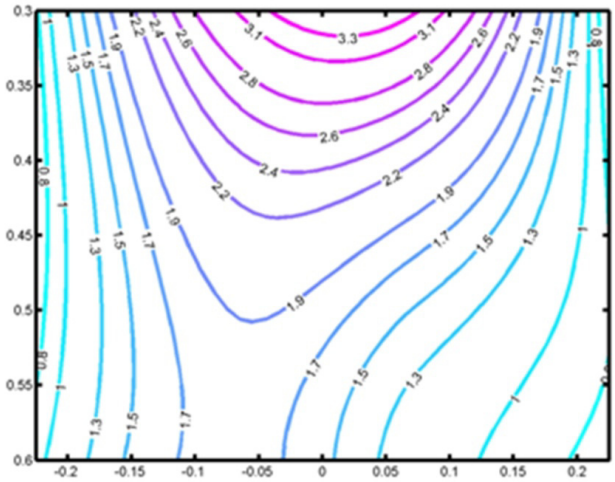

Fig.3. Isolines normal vertical stresses in the base model of the foundation

Editor allows you to perform analysis of previous studies, the results of which are stored in the database, and play diagrams and contour plots for the analysis of tense-deformed condition of the test model.

At the last stage, the program helps to generate a report on the study with the help of "documentation" function. All research results are exported in the HTML- file in the form of tables, charts and graphics.

3. Conclusion

The "SMSP" in conjunction with the system of scientific research bases and foundations in the model has been tested positive with the experiments in the laboratory of the department of PGS G and F SRSTU (NPI) and tested at international level [22].

The introduction of automation in experimental studies to optimize all their stages, to reduce time of analysis and mathematical data processing. In addition, in a field experiment automation allows you to create geotechnical monitoring system.

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